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the numerical values were

$$P=0.2631 \tag{13}$$

$$Q=0.7369 \tag{14}$$

$$L=44.62 \tag{15}$$

$$\frac{P}{L}=0.01651 \tag{16}$$

$$\frac{Q}{L}=0.00590 \tag{17}$$

i. e.,

$$0.2631\,\frac{1}{b}+0.7369\,\frac{1}{d}=44.62. \tag{18}$$

Putting $b=0.03373$ (observed) we find (19)

$$d=0.02000 \text{ (calculated)} \tag{20}$$

as against

$$d=0.020001 \text{ (observed)}. \tag{21}$$

I take this opportunity thus to supplement the data given for the male population in my previous paper. At the time it was written the extraordinarily close agreement between calculated and observed figures for the female population had escaped my notice.

A VECTOR METHOD FOR COMPUTING A WEIGHTED AVERAGE

By R. von Huhn

In terms of dynamics the arithmetic mean is the center of gravity of a distribution. To illustrate this fact we may assume that certain values represent unit weights which are suspended at intervals upon a massless rod. The ideal rod which is under the action of these weights or external forces is at rest or in static equilibrium when the forces balance each other. The location of the fulcrum is therefore the position of the average with respect to the weights.

As the weights or forces have both magnitude and direction (parallel in this case), the two essentials that are necessary for the treatment of data by vector analysis are given.

Suppose we have at hand the statistical data as shown in the following table:

Daily wage class (unit) A	The number of times each unit is encountered or weights B		Product of weight×unit C
$1	..	..	..
$2	4	R_1	8
$3	9	R_2	27
$4	3	R_3	12
$5	..	..	..
$6	5	R_4	30
	21		77
77: 21 $3.66 weighted average			

It is possible to arrive at the value $3.66 by applying the vector method and especially the funicular polygon. This brings out in a striking way the close relationship of certain dynamic principles to certain phases of the statistical science.

Column A in the table represents the unit scale from $1–$6. This scale is drawn in Figure 1 as *MN*, each unit representing one dollar =

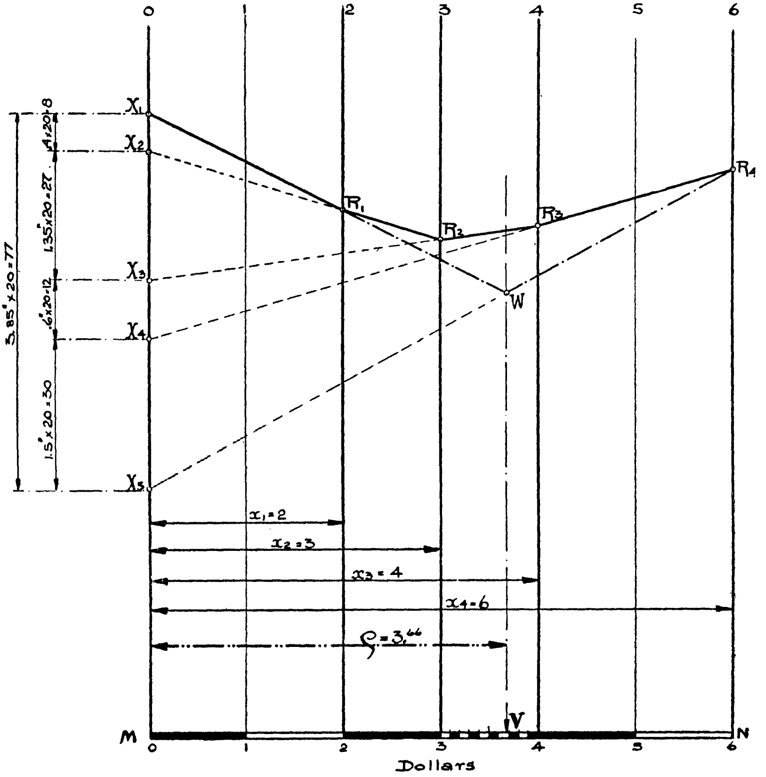

Fig. 1.

one inch. Seven perpendicular lines are drawn in each point; in 0, 1, 2, 3, 4, 5 and finally 6.

The next step is shown in Figure 2, the Polediagram. Draw a line AE parallel R_4N and choose a scale for the weights of Column B in the table. The scale chosen in Figure 2 is $1'' = 5$ dollars. Then add the vectors of the parallel forces R_1 R_2 R_3 R_4 graphically.

Then we have:

$$\begin{array}{l} AB = R_1 = 4 \\ BC = R_2 = 9 \\ CD = R_3 = 3 \\ DE = R_4 = 5 \\ \hline AE = \Sigma R = 21 \end{array}$$

These are the weights which have their corresponding distances from Point O such as x_1, x_2, x_3, x_4, the product of each weight and its corresponding distance giving the moments in the system. Then choose a pole distance $h = 4$ inches (each inch representing 5 weights) perpendicular from the vectors. The pole distance h may be made any length desired as long as a certain scale is chosen. If Point P is connected with the points A, B, C, D, and E the polediagram is completed.

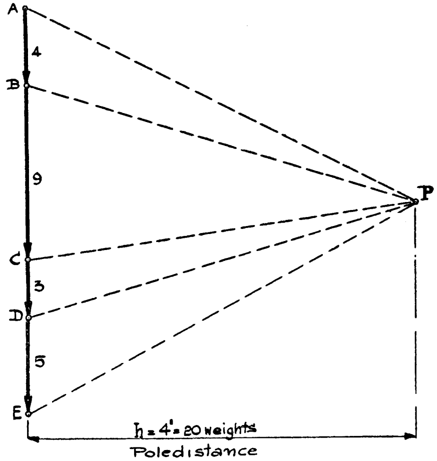

Fig 2.

Then we proceed as follows:

At an arbitrary point X draw a parallel line XR_1 to AP until it intersects with the perpendicular line $2-2$ in R_1; through R_1 draw a parallel line R_1R_2 to BP until it intersects with the perpendicular line $3-3$ in R_2; through R_2 draw a parallel line R_2R_3 to CP until it intersects with the perpendicular line $4-4$ in R_3; through R_3 draw a parallel line R_3R_4 to DP until it intersects with the perpendicular line $6-6$ in R_4.

Then draw a line R_4W through R_4 parallel to EP and extend the line X_1R_1 until it intersects with R_4W in W.

If we draw a line through W parallel to R_4N the point V will give the location of the weighted average on the unit scale MN and $MV = 3.66$ inches = \$3.66.

Proof:

Extend R_4W until it intersects in X_5 with the perpendicular line oo
R_4R_3 " " X_4 "
R_3R_2 " " X_3 "
R_2R_1 " " X_2 "

Then $\triangle PAB$ is similar $\triangle R_1X_1X_2$

$$\therefore\ AB : h = X_1X_2 : x_1$$

hence $$AB \cdot x_1 = h \cdot X_1X_2$$

again $\triangle PBC$, $\triangle PCD$, $\triangle PDE$ are similar to $\triangle R_2X_2X_3$, $\triangle R_3X_3X_4$, $\triangle R_4X_4X_5$ respectively.

Furthermore:

$$\begin{aligned} AB \cdot x_1 &= h \cdot X_1X_2 = .40'' \times 20 = 8.^\circ \\ BC \cdot x_2 &= h \cdot X_2X_3 = 1.35'' \times 20 = 27.^\circ \\ CD \cdot x_3 &= h \cdot X_3X_4 = .60'' \times 20 = 12.^\circ \\ DE \cdot x_4 &= h \cdot X_4X_5 = 1.50'' \times 20 = 30.^\circ \end{aligned}$$

Added $$h(X_1X_2 + X_2X_3 + X_3X_4 + X_4X_5) = 3.85'' \times 20 = 70.^\circ$$

$$h = 20 \text{ weights} = \text{Poledistance}$$

$$X_1X_5 = 3.85''$$

Furthermore:

$$\triangle APE \text{ similar } \triangle WX_1X_5$$

$$\therefore\ \triangle APE : \triangle WX_1X_5 = h : \rho$$

$$\rho = \text{distance } MV = \text{Location of weighted average}$$

hence

$$AE : X_1X_5 = h : \rho$$

$$\rho = h\frac{X_1X_5}{AE}$$

$$= 20\frac{3.85}{21} = \frac{77}{21}$$

$$\rho = 3.66 \text{ Dollars.}$$